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GB 2147938 A GB 2031481 A GB 2002047 A
GB 1579063 A GB 1515491 A GB 1376094 A
GB 1366495 A US 4546841 A

(58) Field of search
UK CL (Edition J) E1F FCM
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(54) Drilling and lining a borehole

(57) A lining assembly 2 is advanced through a borehole which is being formed independently by a drilling tool 4 driven by a simultaneously advancing drilling assembly 1 and which has a diameter greater than the external diameter of the lining assembly 2. The drilling assembly 1 (with or without the tool 4) is withdrawn through the lining assembly 2, which is left in the borehole, preferably after cementing in place. The tool 4 has collapsible under-reamer arms 6. The lining assembly 2 is pulled along by and rotated by the drilling assembly 1.

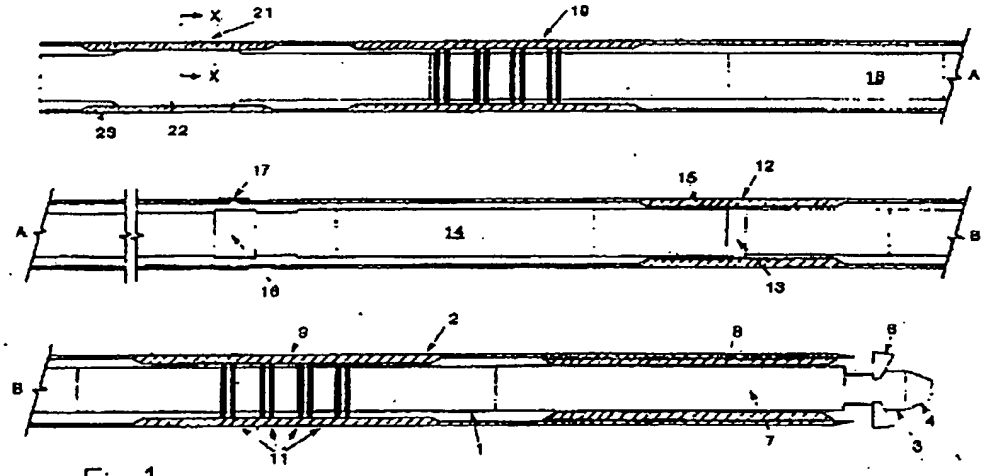

Fig. 1

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

The claims were filed later than the filing date within the period prescribed by Rule 25(1) of the Patents Rules 1982.

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DRILLING METHOD AND APPARATUS

This invention relates to a method and apparatus for drilling and lining a borehole.

Conventionally, a borehole is first drilled by a drilling assembly, which is removed from the borehole, and a lining assembly is subsequently inserted into the borehole and usually cemented in place.

However, this procedure is unsatisfactory in an unconsolidated formation and/or when the borehole is horizontal or highly deviated from the vertical, since the walls of the borehole may collapse before the lining assembly can be inserted. In order to overcome this difficulty it has been suggested to provide the drilling assembly with a casing which is rotated and which is formed with a reaming bit for reaming the borehole to a larger diameter than the casing, which is left in the borehole as a lining while the rest of the drilling assembly is withdrawn (see GB-A-2 054 008 and EP-A1-0 241 354). Such a procedure could only produce short lengths of borehole, because of the friction between the casing and the borehole walls and

the resistance to rotation of the casing provided by the reaming bit formed on the casing. There is thus a serious problem to be solved, particularly if boreholes more than 150m in length are to be achieved, as is often required in the petroleum industry.

In order to overcome this problem, the present invention is based on the idea of advancing a lining assembly and a drilling assembly together and withdrawing the drilling assembly through the lining assembly once the drilling operation is complete or if the drilling tool becomes stuck or needs to be replaced.

The invention provides a method of drilling and lining a borehole, comprising the steps of (a) drilling a borehole by advancing a drilling assembly driving a drilling tool which makes the borehole and simultaneously advancing a lining assembly surrounding the driving assembly, so as to line the borehole which is being formed by the drilling assembly independently of the lining assembly and which has a diameter greater than the external diameter of the lining assembly, and subsequently (b) withdrawing the drilling assembly through the lining assembly and leaving the lining assembly in the borehole. Preferably, the lining assembly is cemented in place before step (b).

The invention also provides apparatus for drilling and lining a borehole, comprising a lining assembly, a drilling assembly which extends through the lining assembly, and a drilling tool which is independent of the lining assembly and which is drivable by the drilling assembly for drilling a borehole having a diameter greater than the external diameter of the lining assembly, the drilling assembly being withdrawable through the lining assembly.

It is possible to leave all or part of the drilling tool behind when withdrawing the drilling assembly, but preferably the tool is also withdrawable through the lining assembly; this can be achieved with a tool comprising reaming means which are movable between an operative position and an inoperative position in which the maximum transverse dimension of the tool is less than the minimum internal diameter of the lining assembly.

The lining assembly may be advanced simultaneously by being drawn along by the drilling assembly, for which purpose it may be connected to the drilling assembly by releasable locking means. Since the lining assembly is pulled by the drilling assembly (rather than pushed, as in GB-A-2054 008 and EP-A1-0 241 354), the lining

assembly can be kept in tension, thus avoiding any risk of collapse of the lining assembly through buckling under compression. In order to reduce friction resisting the advance of the lining assembly, it may be rotated, e.g., via the drilling assembly.

The invention will be described further, by way of example only, with reference to the accompanying drawings, in which:

Fig 1 is a diagrammatic axial section through a borehole drilling and lining apparatus, in which the axial and radial dimensions are not to scale; and

Fig 2 is a section on line x-x in Figure 1.

In the following description all the dimensions are typical dimensions given only as examples; they are not to be taken as limiting or restricting the scope of the invention. The apparatus illustrated comprises a drilling assembly 1 which extends through a lining assembly 2 and which carries a drilling tool 3.

The lining assembly 2 is mainly made up of steel pipe joints of seamless casing or liner pipe with an outer

diameter of 7.00 inch (178mm) and an inner diameter of 6.18 inch (157mm). The minimum internal diameter of the lining assembly is 4.60 inch (117mm).

The drilling assembly 1 is mainly made up of steel pipe joints of drill collar type with an outer diameter of 4.50 inch (114mm). The drilling tool 3 is a combination tool comprising a pilot hole bit 4 of 4.50 inch (114mm) diameter carrying a hydraulically operated under-reamer having arms 6 capable of drilling a hole 8.50 inch (216mm) in diameter when in the operative position (as shown). The arms 6 are collapsible to an inoperative position in which the maximum transverse dimension of the tool 3 is no greater than the diameter of the pilot hole drilled by the bit 4. In this position the tool 3 can be withdrawn together with the drilling assembly 1 through the lining assembly 2.

The tool is driven by an hydraulic drilling motor 7 which is 4.50 inch (114mm) in diameter, with the possibility of using a straight motor, a single bend motor, or a multiple (e.g.3) bend motor for directional drilling or steering. The motor 7 is arranged in a seamless liner 8, outer diameter 5.50 inch (140mm) and inner diameter 4.65 inch (118mm), centralised and fixed in the lining assembly 2.

A bottom seal assembly comprises a 15ft (4.6m) pipe 9 shrink fitted in the lining assembly and having its inner bore machined to 4.60 inch (117mm) as a polished bore receptacle to receive seal packing elements 11 on the drilling assembly.

The lining assembly 2 is releasably locked to the drilling assembly 1 by a so-called J-latch assembly 12 so that the lining assembly advances with the drilling assembly. The J-latch assembly 12 comprises three welded J-locking pegs or keys (not shown) protruding to an outer diameter of 5.20 inch (132mm) from a region 13 built up to a diameter of 4.70 inch (119mm) by build-up welding on the drilling assembly. An 8 ft (2.4 m) length of pipe 14, shrink fitted in the lining assembly and having a minimum internal diameter of 4.75 inch (121 mm) is machined on the inner surface with a double latching profile to accept the above-mentioned keys to enable locking and unlocking of the J-latch assembly 12 in the matter of a bayonet fitting.

The drilling assembly 1 includes a measurement-while-drilling hole survey package 14 with mud pulse telemetry and logging tools such as a gamma

ray and cased hole compensated neutron tool. In the region of the package 14 the joints of the lining assembly 2 are made of Monel (Trade Mark) alloy.

To enable cementing of the borehole before withdrawing the drilling assembly 1, the assembly 1 includes a known circulating substitute 16 comprising a pump-open circulating port device opened by pumping down a plastics ball which seats in the substitute 16 and compresses a spring allowing a sleeve to be moved downwards so that ports in the sleeve are aligned with ports in the body of the substitute 16. A non-return sliding sleeve valve 17 in the lining assembly 2 is opened by the pump pressure.

Above a variable number of spacer joints the drilling assembly has a slip/bumper joint 18, described further below, followed by a top seal assembly 19 similar to the bottom seal assembly (9,11) described above. Finally at the upper end of the apparatus there is a spline drive assembly 21 for transmitting rotation from the drilling assembly 1 to the lining assembly 2. The assembly 21 includes a male spline section 22 with a length of 24 inch (610mm) shrink fitted on a drill collar type pipe and having splines with an outer diameter of 5.76 inch (146mm) and a radial depth of 0.19 inch (48mm). This

meshes with a female spline section 23 with a length of 40 inch (1m) shrink fitted in the lining assembly and having splines with an inner diameter of 5.48 inch (139mm) and a radial depth of 0.19 inch (4.8mm).

The joint 18 is a sliding piston slip joint/jar adapted to permit positive snap shutting and locking on downward movement, and with positive spring assisted snap opening and locking with sufficient travel to enable disengagement of the spline sections 22,23. The threshold compressive force to overcome the snap opening is greater than the downward force required to advance the drilling assembly within the lining assembly and manipulate the J-latch assembly 12.

The drilling apparatus described above enables the simultaneous drilling of a borehole and setting of protective casing in highly deviated or horizontal holes as well as ordinary holes.. The technique and assembly permit the achievement of a cased and cemented horizontal or highly deviated hole at vertical drilled depths of approx. 1-3km and having horizontal sections of more than 150m in extent.

This can be achieved;

(1) without having to leave newly drilled hole unprotected;

(2) by permitting the retrieval of the drilling bit and assembly while at the same time leaving the hole protected by the lining assembly simultaneously set in position at the time of drilling such that drill bits or other tools may be changed during drilling or retrieved at the end of drilling;

(3) by permitting the drilling bit or face to be driven by an hydraulic drilling motor but at the same time enabling the protective casing to be rotated (at a lower speed) by the surface rotating drive equipment.

The above-described method and apparatus exhibit the following advantages over other techniques and in addition to those listed above, as follows;

(1) the necessity to incur a separate sequence of operations for the setting of casing, thus leaving newly drilled hole unprotected, is eliminated;

(2) the drilling face or bit is rotationally independent of the lining, thus permitting different speeds of rotation to be applied to drill bit and liner pipe;

(3) the drilling assembly and drill bit may be pulled out of the hole for changing of tools or for retrieval at the end of drilling, thus saving on high 'left-in-hole' capital equipment costs;

(4) the method of insertion of the drilling assembly within the casing permits the flexibility of being able to drill and simultaneously protect holes of (variable) horizontal extent in excess of 500m;

(5) it is possible to drill in unconsolidated formations, where hole caving has been a problem;

(6) retrieval of the drilling assembly after drilling is terminated permits further completion and/or drilling operations in a well;

(7) the apparatus also permits the addition of further tools to the down-hole assembly, such as cement circulation equipment and down-hole surveying equipment.

(8) the lining assembly can be cemented in the borehole before the drilling assembly is withdrawn;

(9) if the lining assembly gets stuck during drilling, the drilling assembly can be withdrawn and replaced by another lining assembly and drilling assembly of smaller diameter.

CLAIMS:-

1. A method of drilling and lining a borehole, comprising the sequential steps of

(a) drilling a borehole by advancing a drilling assembly driving a drilling tool which makes the borehole and simultaneously advancing a lining assembly surrounding the drilling assembly, so as to line the borehole which is being formed by the drilling assembly independently of the lining assembly and which has a diameter greater than the external diameter of the lining assembly, and

(b) withdrawing the drilling assembly through the lining assembly and leaving the lining assembly in the borehole.

2. A method as claimed in claim 1, in which the lining assembly is drawn along by the drilling assembly during step (a).

3. A method as claimed in claim 1 or 2, in which the lining assembly is rotated during step (a).

4. A method as claimed in claim 3, in which the lining assembly is rotated via the drilling assembly.

5. A method as claimed in any preceding claim, in which the lining assembly is cemented in place before step (b).

6. A method as claimed in any preceding claim, in which the drilling tool is withdrawn together with the drilling assembly.

7. Apparatus for drilling and lining a borehole, comprising a lining assembly, a drilling assembly which extends through the lining assembly, and a drilling tool which is independent of the lining assembly and which is drivable by the drilling assembly for drilling a borehole having a diameter greater than the external diameter of the lining assembly, the drilling assembly being withdrawable through the lining assembly.

8. Apparatus as claimed in claim 7, in which the drilling tool comprises reaming means which are movable between an operative position and an inoperative position in which the maximum transverse dimension of the tool is less than the minimum internal diameter of the lining assembly.

9. Apparatus as claimed in claim 7 or 8, including releasable locking means for connecting the lining assembly to the drilling assembly so as to be drawn

along by it.

10. Apparatus as claimed in any of claims 7 to 9, including means for rotating the lining assembly.

11. Apparatus as claimed in any of claims 7 to 10, in which the drilling assembly includes a hydraulic drilling motor for driving the drilling tool.

12. Apparatus as claimed in any of claims 7 to 11, in which the lining assembly includes a non-return valve through which cement can be pumped from the drilling assembly.

13. A method of drilling and lining a borehole, substantially as described with reference to the accompanying drawings.

14. Apparatus for drilling and lining a borehole, substantially as described with reference to, and as shown in, the accompanying drawings.

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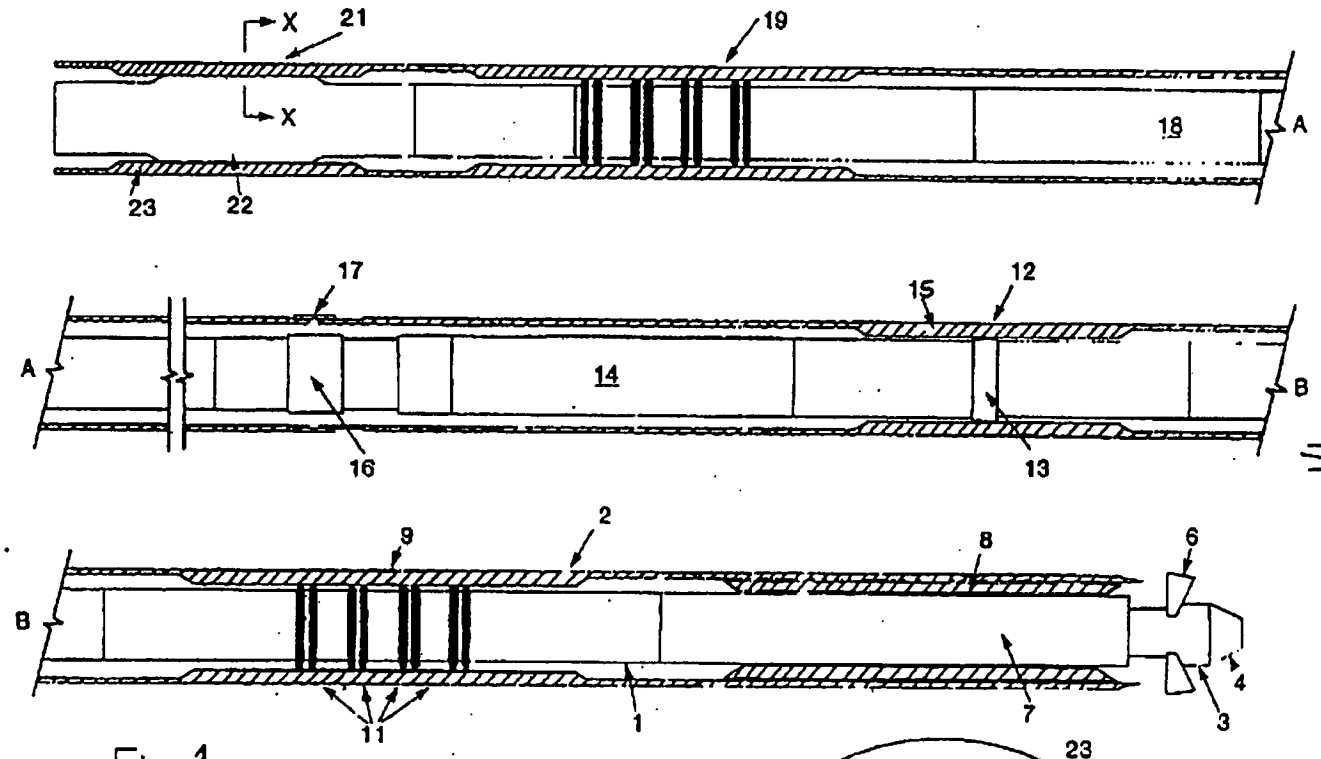

Fig. 1

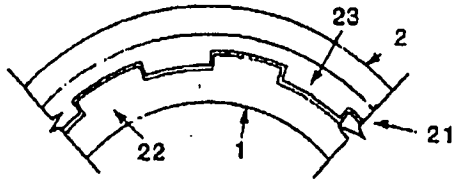

Fig. 2

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